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Sekimoto et al.

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(54) **IMAGE FORMING APPARATUS**

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(52) **U.S. Cl.**
CPC ***B41J 11/002*** (2013.01)

(58) **Field of Classification Search**
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USPC 347/102
See application file for complete search history.

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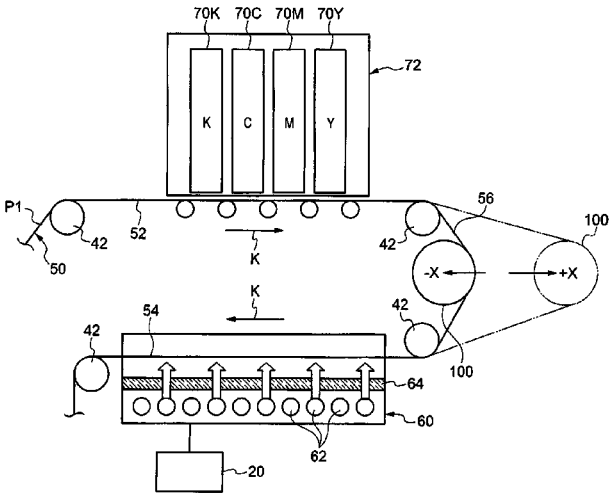
(57) **ABSTRACT**

An image forming apparatus includes: a conveying device that conveys a recording medium; a droplets ejecting device that ejects droplets onto the recording medium being conveyed by the conveying device; a drying unit that dries the droplets that have been ejected on the recording medium being conveyed by the conveying device; and a varying unit that varies a conveyance path length from the droplets ejecting device to the drying unit in accordance with at least one of a conveyance speed of the recording medium and an ejected droplets permeation characteristic of the recording medium.

2 Claims, 11 Drawing Sheets



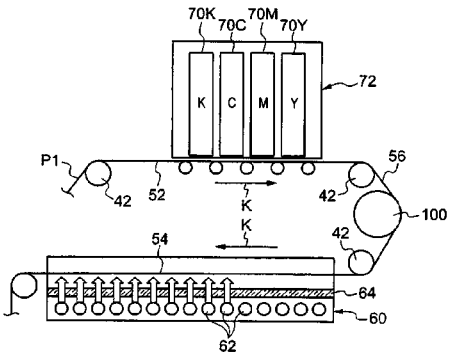
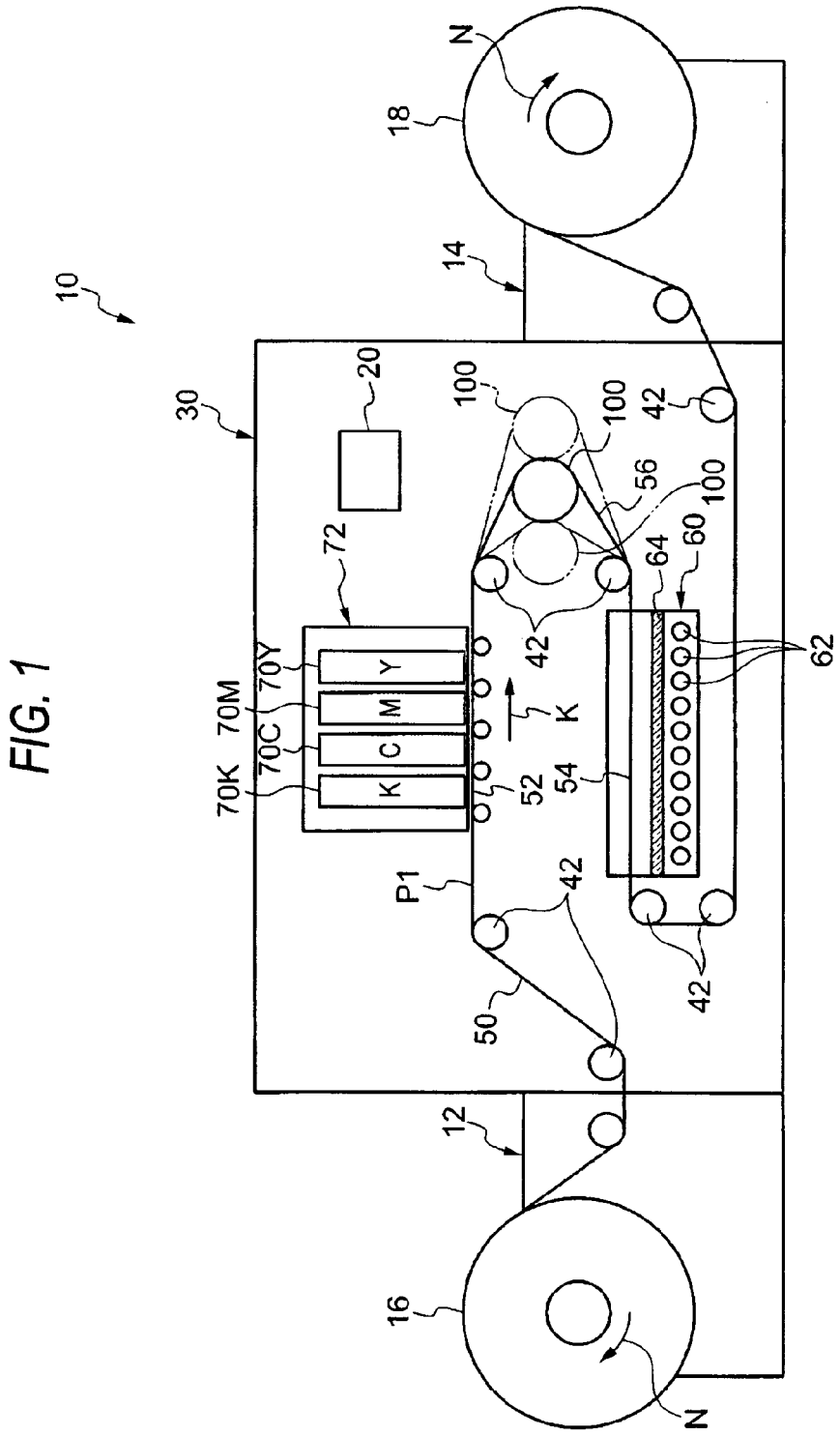


FIG. 1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18
N
14
30
20
100
100
42
56
100
72
64
60
62
42
70Y
Y
70M
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C
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K
K
52
54
P1
42
42
50
12
16
N

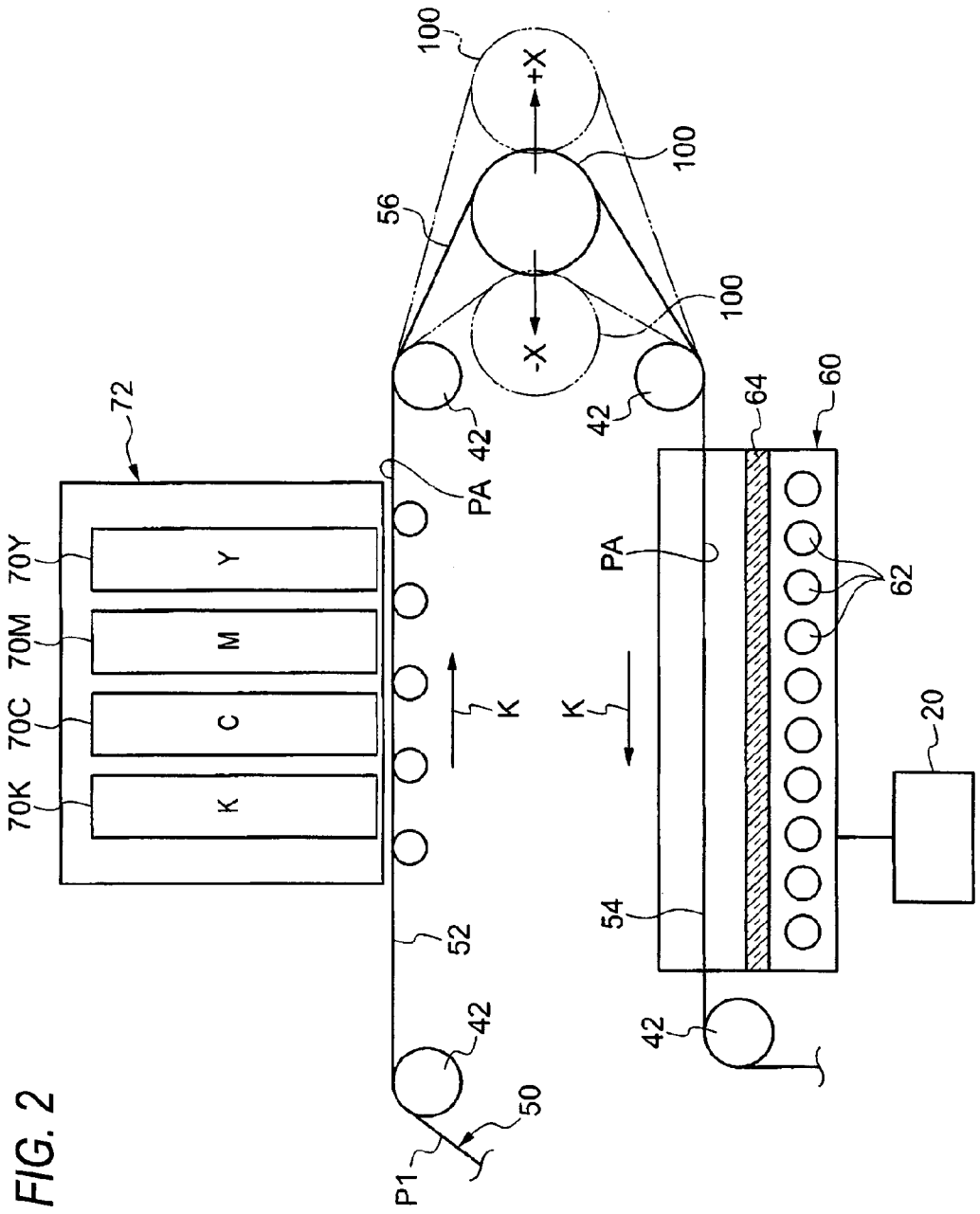

100
+X
100
56
-X
100
72
42
42
64
60
PA
PA
62
70Y
Y
70M
M
70C
C
70K
K
K
K
20
54
52
42
42
50
P1

FIG. 2

FIG. 3A

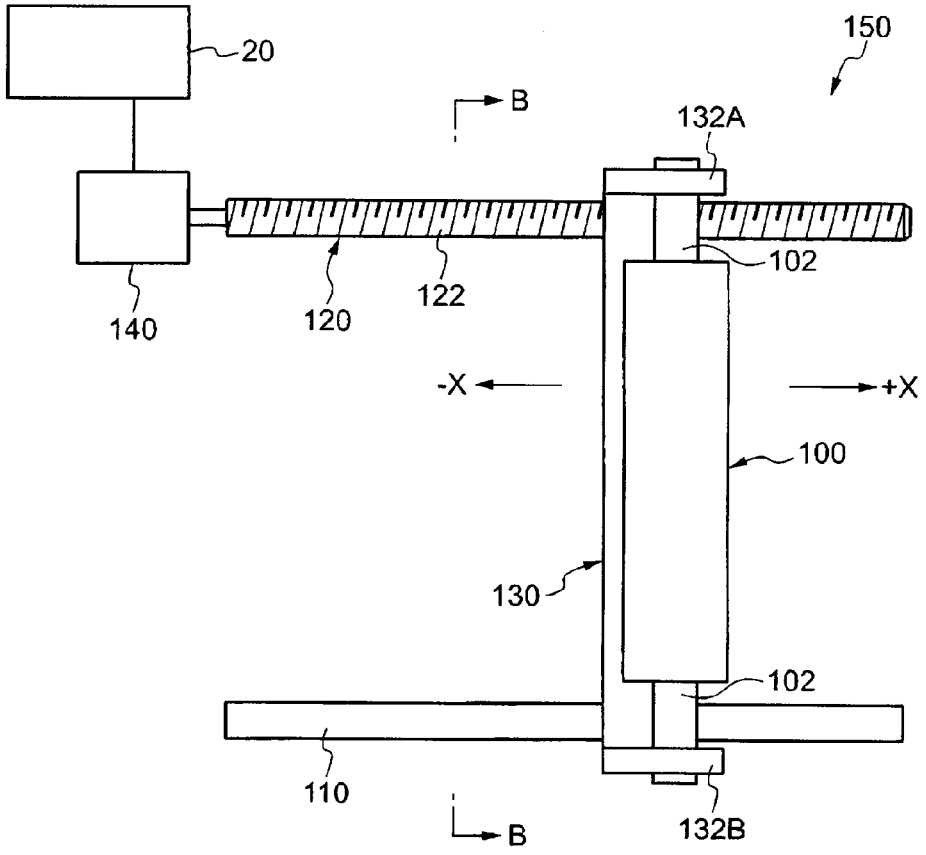

20
150
B
132A
102
140
120
122
-X
+X
100
130
102
110
B
132B

FIG. 3B

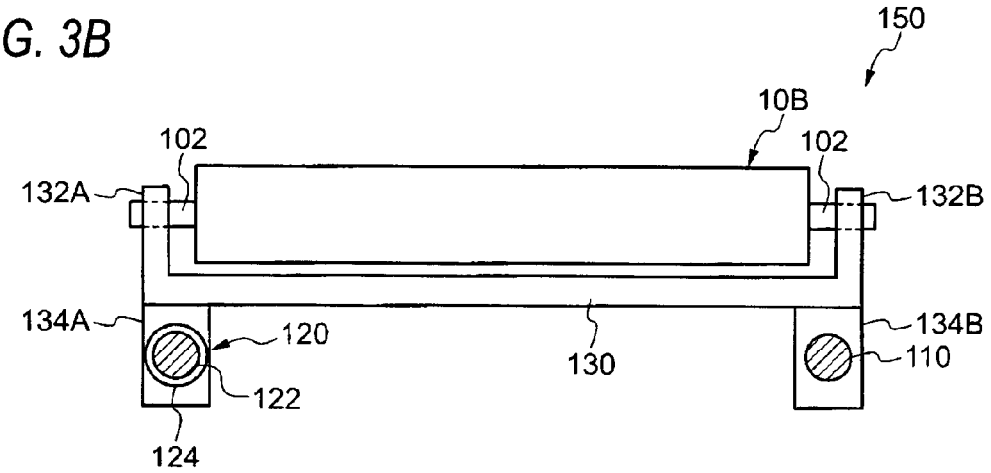

150
10B
102
102
132A
132B
134A
120
130
134B
110
122
124

FIG. 4A

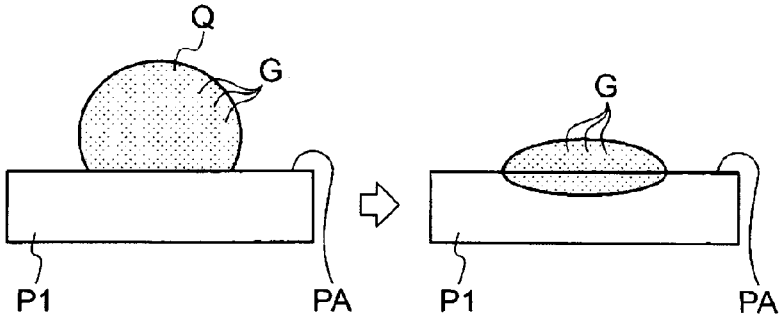


FIG. 4B

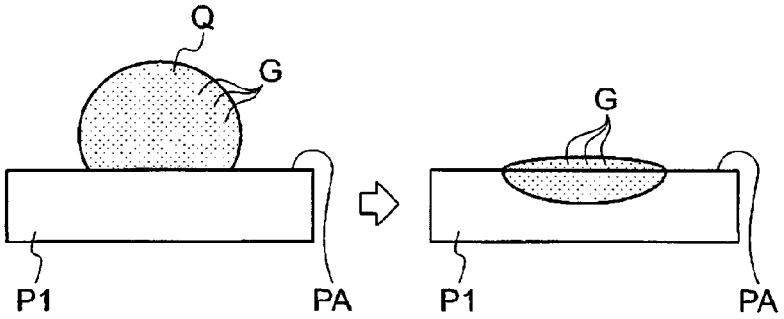


FIG. 4C

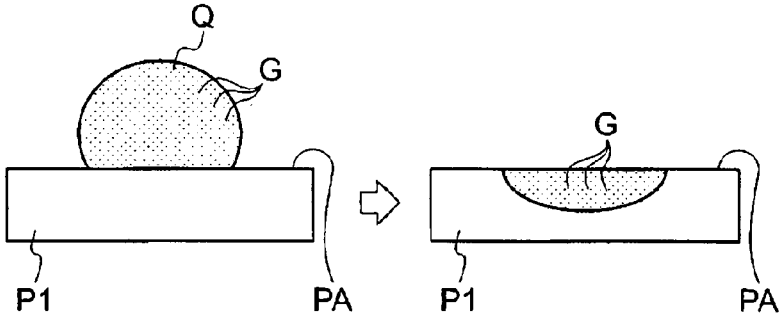


FIG. 5A

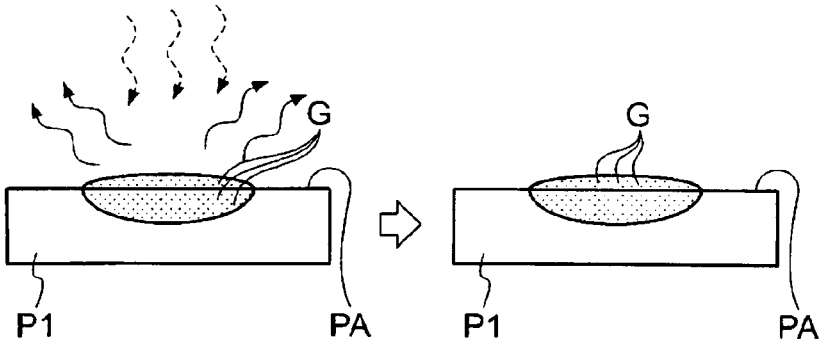


FIG. 5B

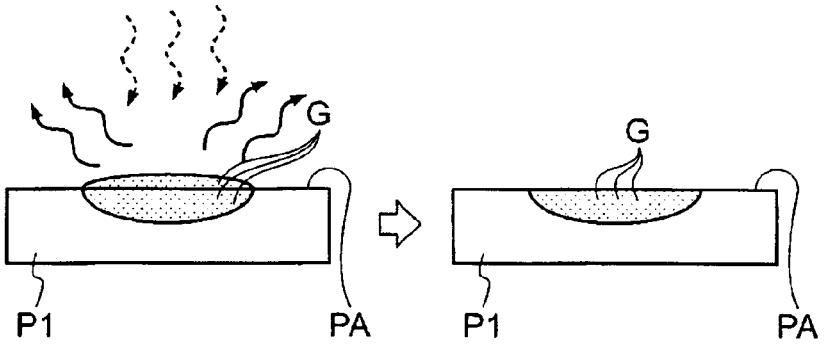
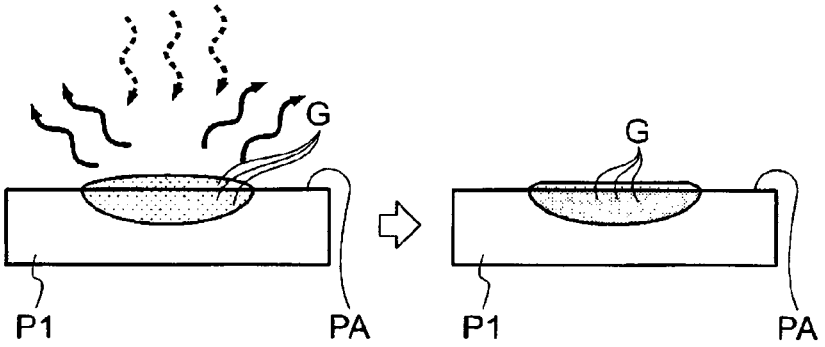


FIG. 5C



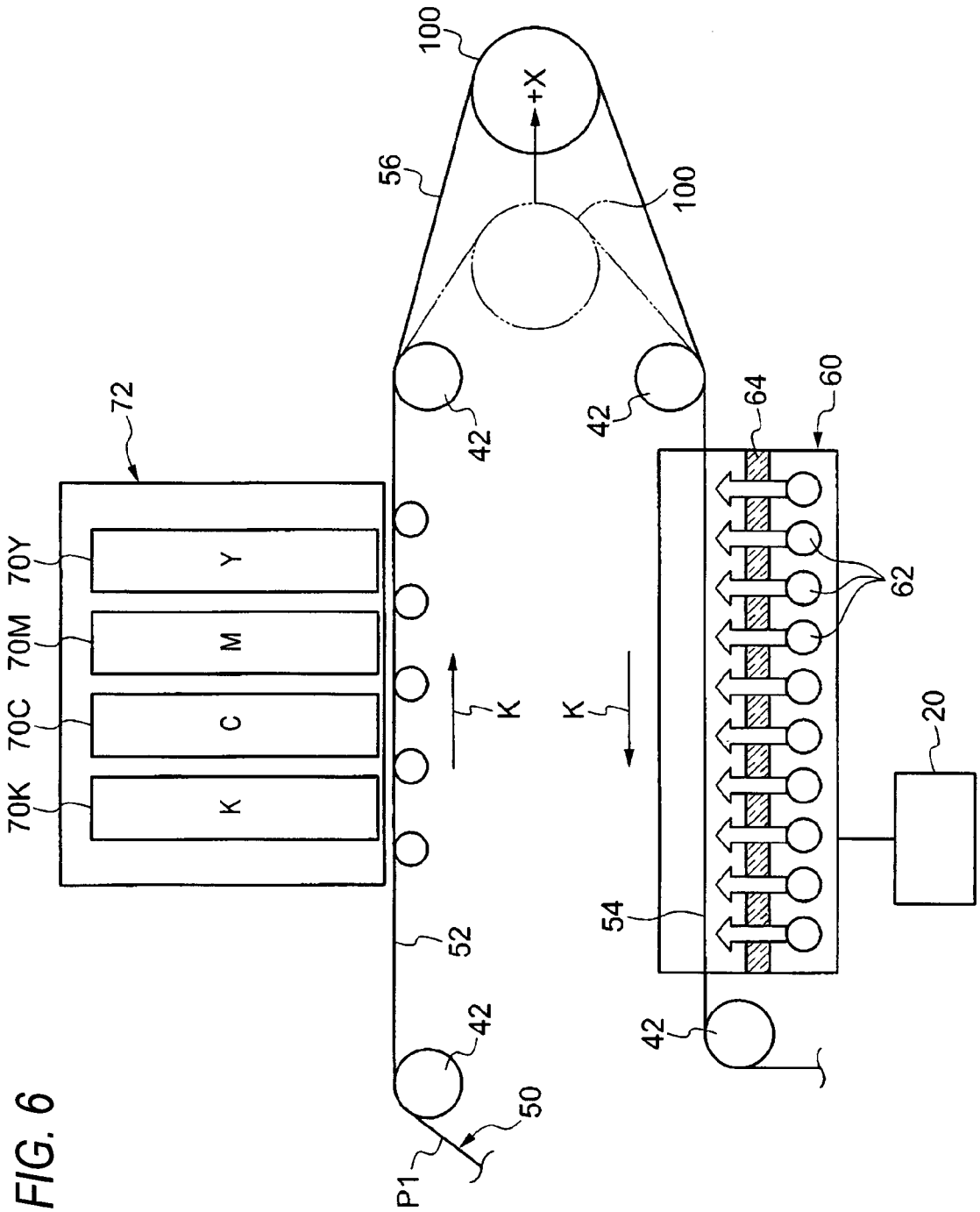

100
+X
56
100
42
42
64
60
72
70Y
70M
70C
70K
Y
M
C
K
62
K
K
20
54
52
42
42
50
P1

FIG. 6

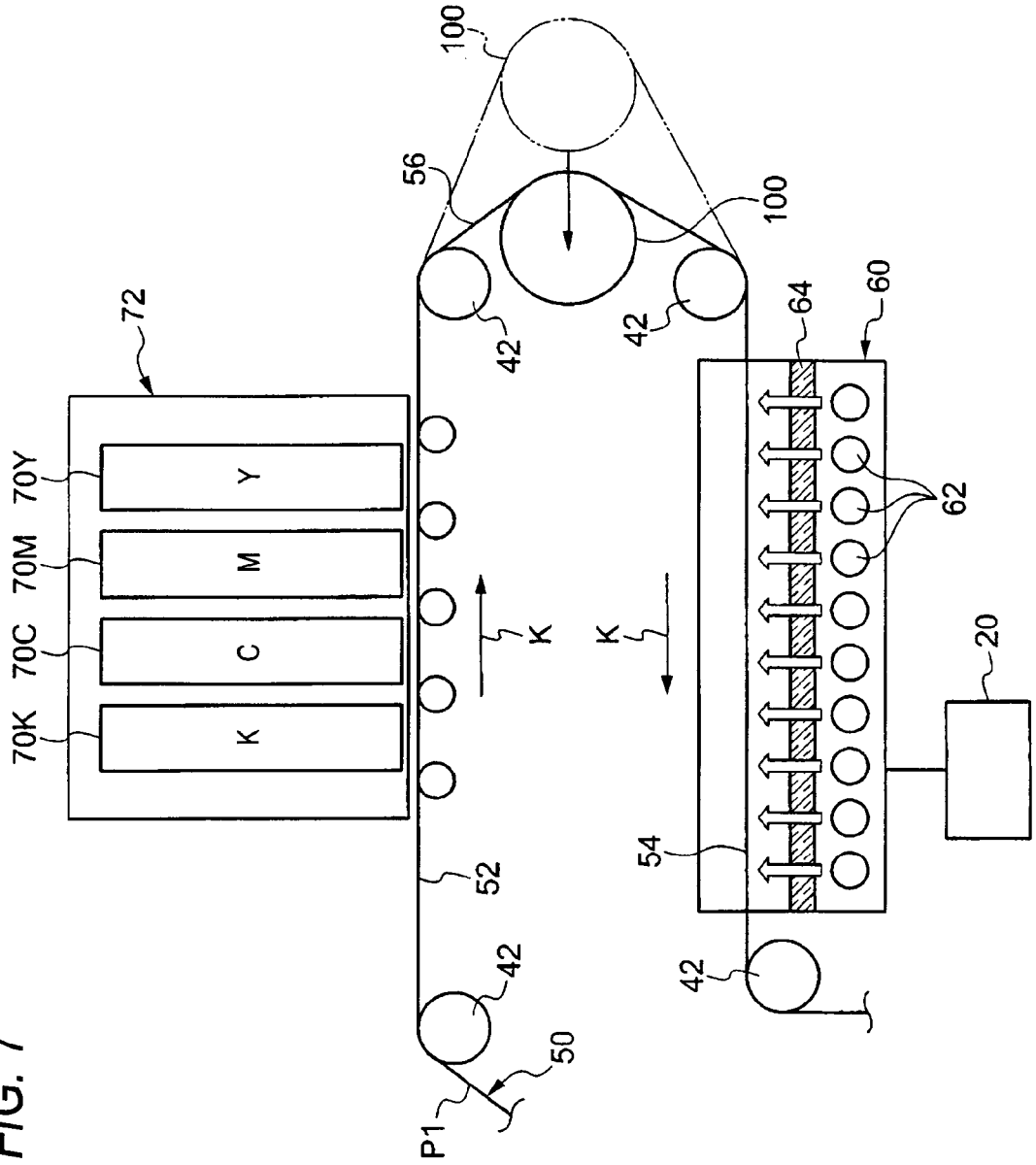

100
56
100
42
42
64
60
72
70Y
Y
70M
M
70C
C
70K
K
K
K
62
20
54
52
42
42
50
P1

FIG. 7

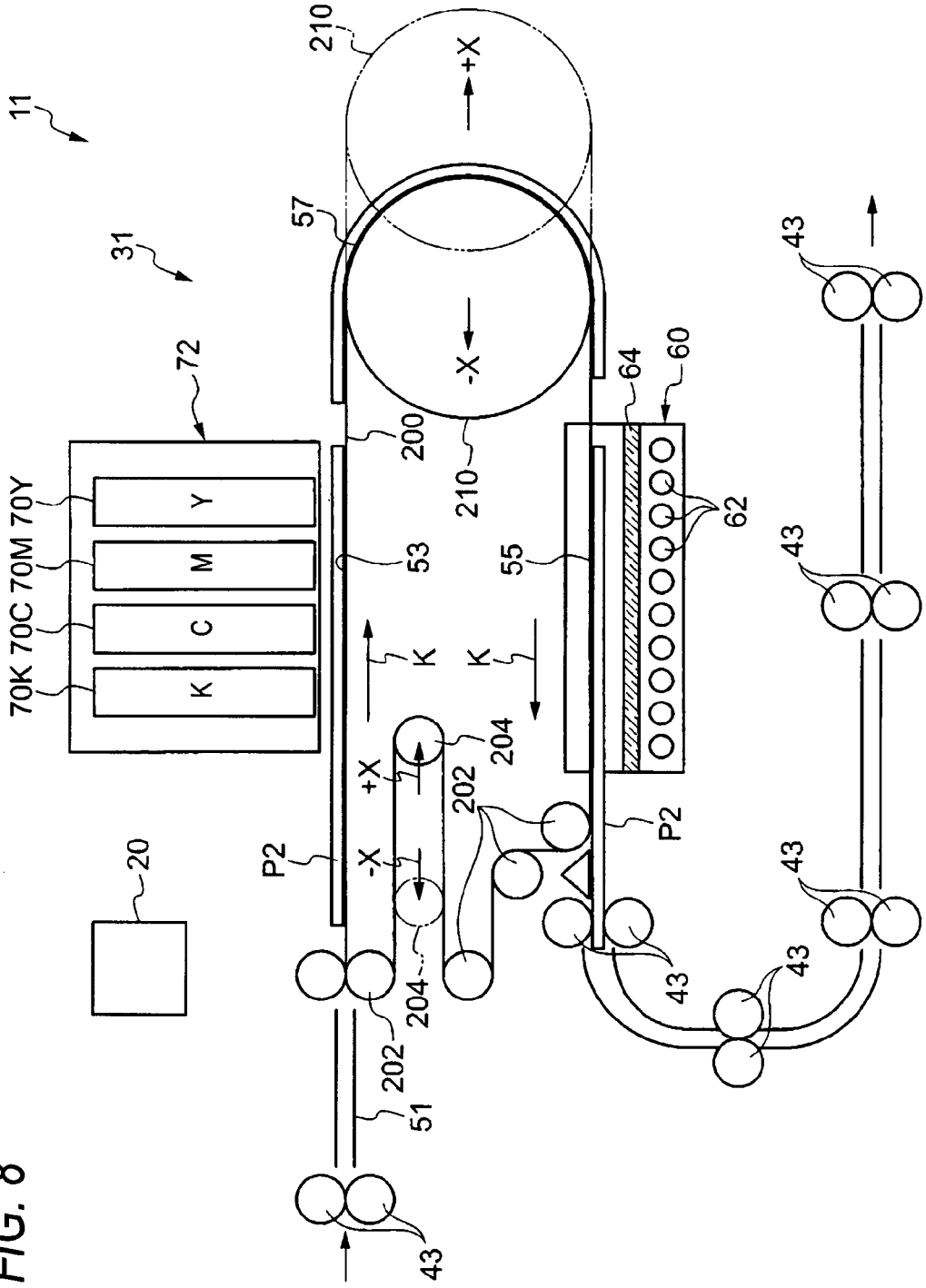

11
31
72
70K 70C 70M 70Y
K
C
M
Y
20
210
+X
-X
57
200
53
55
64
60
62
K
204
202
P2
51
43

FIG. 8

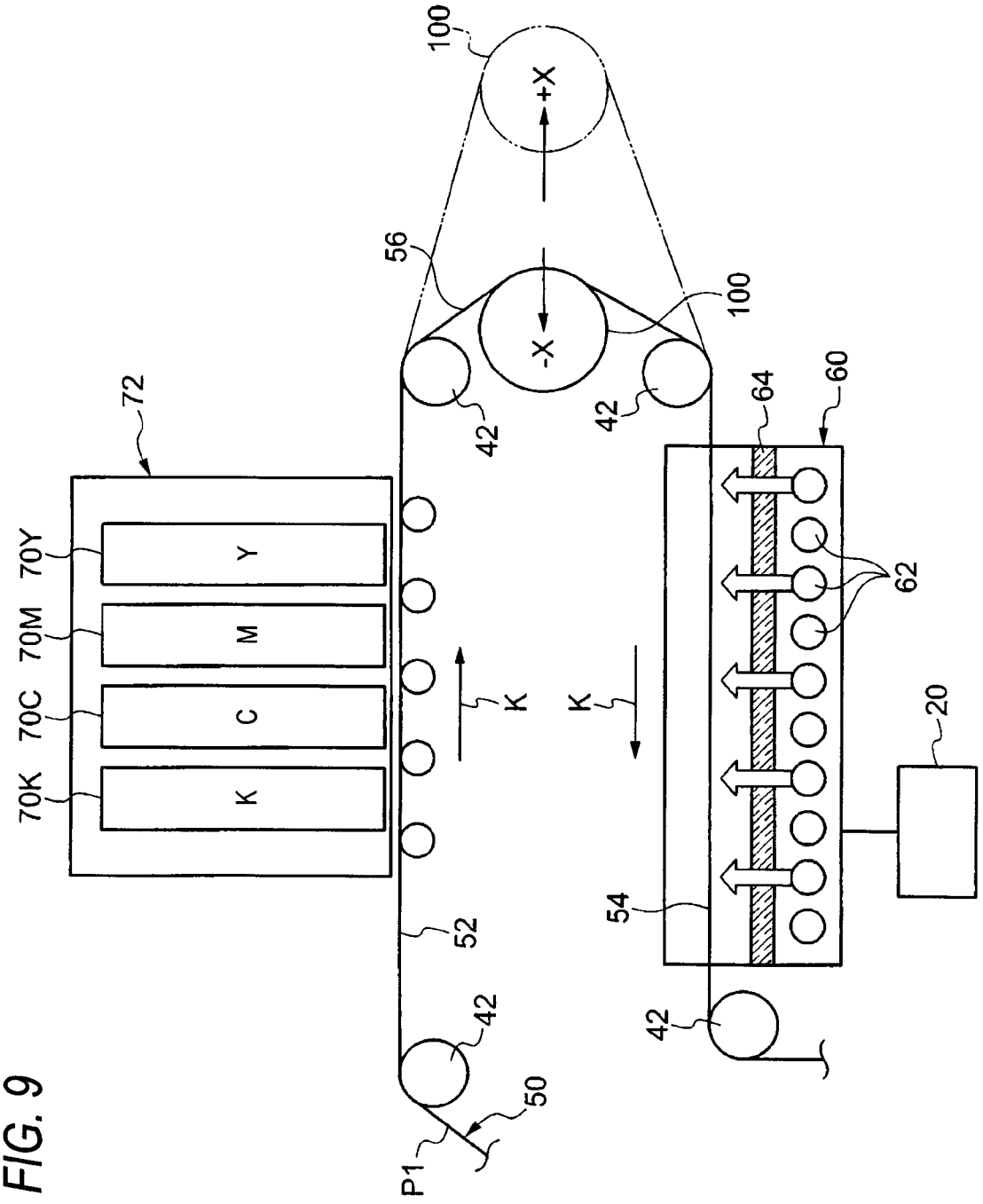

100
+X
-X
56
42
42
100
64
60
72
70Y
70M
70C
70K
Y
M
C
K
K
K
62
20
54
52
42
42
50
P1

FIG. 9

FIG. 10A

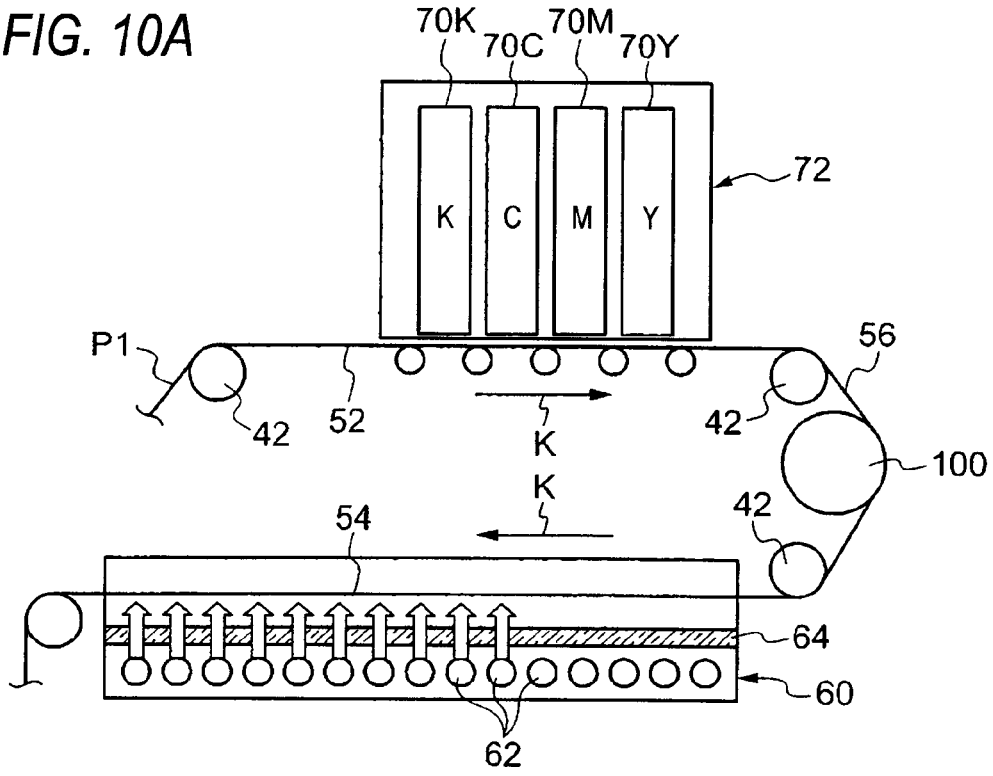


FIG. 10B

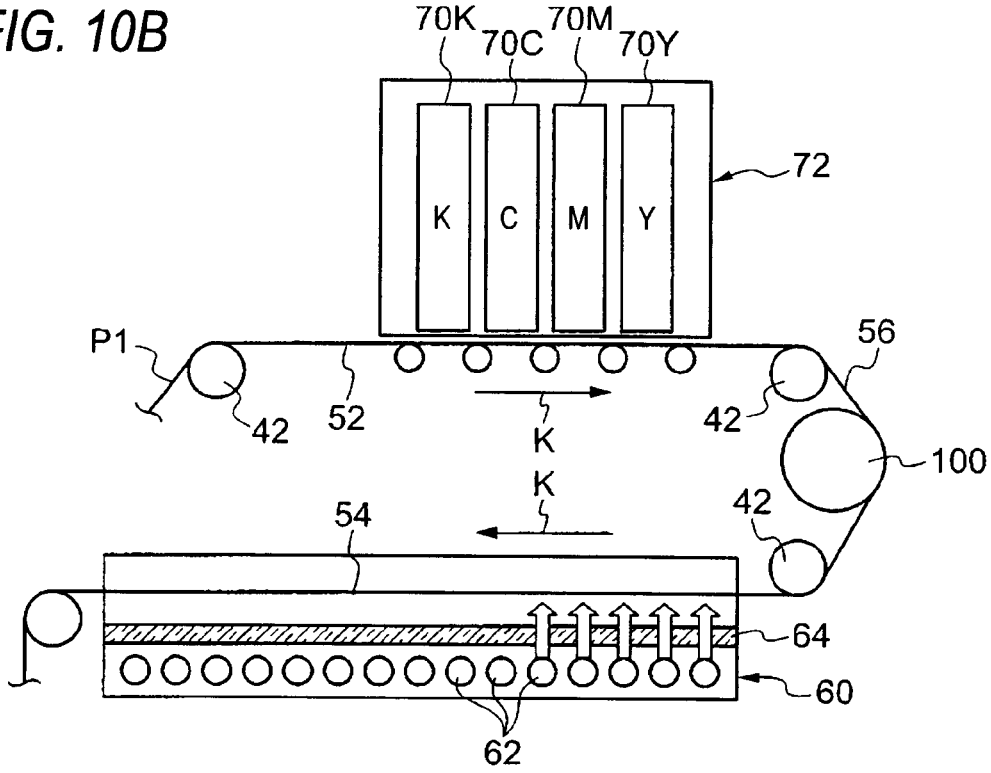


FIG. 11

TYPE	FEATURES	PERMEATION SPEED (PERMEATION CHARACTERISTIC)	CONVEYANCE PATH LENGTH
PLAIN PAPER	FOR GENERAL USE	STANDARD (SETTING: 0 (REFERENCE))	STANDARD
GLOSSY PAPER	GLOSSY, FOR HIGH-RESOLUTION, HIGH REPRODUCIBILITY PRINTING	HIGHER THAN STANDARD (SETTING: +1)	SHOULD BE SET SHORTER THAN STANDARD
THICK MATTE PAPER	LESS GLOSSY THAN COATED SHEET FOR HIGH-RESOLUTION, HIGH REPRODUCIBILITY PRINTING	MUCH HIGHER THAN STANDARD (SETTING: +2)	SHOULD BE SET MUCH SHORTER THAN STANDARD
YOPO PAPER (SYNTHETIC PAPER)	RESISTANT TO WATER AND OIL AND HARD TO BREAK	LOWER THAN STANDARD (SETTING: -1)	SHOULD BE SET GREATER THAN STANDARD
THICK JAPANESE PAPER	VERY THICK JAPANESE PAPER THAT ENABLE DOUBLE-SIDED PRINTING	MUCH LOWER THAN STANDARD (SETTING: -2)	SHOULD BE SET MUCH GREATER THAN STANDARD
COATED PAPER FOR PRINTING AND PUBLISHING	COATED WITH WHITE PIGMENT, ETC.	MUCH LOWER THAN STANDARD (SETTING: -2)	SHOULD BE SET MUCH GREATER THAN STANDARD
NEWSPAPER	VERY THIN NEWSPAPER	MUCH HIGHER THAN STANDARD (SETTING: +2)	SHOULD BE SET MUCH SHORTER THAN STANDARD

IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2013-216750 filed on Oct. 17, 2013.

BACKGROUND

Technical Field

The present invention relates to an image forming apparatus.

SUMMARY

According to an aspect of the invention, there is provided an image forming apparatus comprising a conveying device which conveys a recording medium; a droplets ejecting device for ejecting droplets onto the recording medium being conveyed by the conveying device; a drying unit for drying the droplets that have been ejected on the recording medium being conveyed by the conveying device; and a varying unit for varying a conveyance path length from the droplets ejecting device to the drying unit in accordance with at least one of a conveyance speed of the recording medium and an ejected droplets permeation characteristic of the recording medium.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically shows the overall configuration of an image forming apparatus according to a first exemplary embodiment.

FIG. **2** schematically shows the configuration of an essential part of an image forming unit of the image forming apparatus according to the first exemplary embodiment shown in FIG. **1**.

FIG. **3**A is a schematic plan view of a moving mechanism, and FIG. **3**B is a partially sectional (taken along line B-B), side view of the image forming unit shown in FIG. **3**A.

The left part of each of FIGS. **4**A, **4**B and **4**C schematically shows a state immediately after ejecting of a droplet onto a recording medium, and the right part of each of FIGS. **4**A, **4**B and **4**C schematically shows a state that a time has elapsed from the state of the left part and the droplet has permeated into the recording medium; the right parts of **4**A, **4**B and **4**C correspond to cases that the permeation is insufficient, proper, and excessive, respectively.

The left part of each of FIGS. **5**A, **5**B and **5**C schematically shows a state that the droplet that has permeated properly into the recording medium (see the right part of FIG. **4**B) is being dried by the dryer **60**, and the right part of each of FIGS. **5**A, **5**B and **5**C schematically shows a state that a time has elapsed from the state of the left part and the droplet has been dried; the right parts of **5**A-**5**C correspond to cases that the drying is insufficient, proper, and excessive, respectively.

FIG. **6** illustrates a state that the conveyance path length is increased and the output power of infrared heaters is increased when the conveyance speed is high.

FIG. **7** illustrates a state that the conveyance path length is shortened and the output power of infrared heaters is lowered when the conveyance speed is low.

FIG. **8** schematically shows the configuration of an essential part of an image forming unit of an image forming apparatus according to a second exemplary embodiment.

FIG. **9** illustrates a state that the conveyance path length is shortened and the number of turned-on infrared heaters is decreased when the conveyance speed is low (first modification).

FIG. **10**A illustrates a state that the conveyance path length is increased by shifting the turning-on start position of the infrared heaters to the downstream side and the number of turned-on infrared heaters is increased when the conveyance speed is high, and FIG. **10**B illustrates a state that the conveyance path length is decreased by shifting the turning-on start position of the infrared heaters to the upstream side and the number of turned-on infrared heaters is decreased when the conveyance speed is low (second modification).

FIG. **11** is a table showing example relationships between droplets permeation characteristics (permeation speeds) and conveyance path lengths of various types of recording media.

DESCRIPTION OF SYMBOLS

10: Image forming apparatus
11: Image forming apparatus
30: Image forming unit (example conveying device)
31: Image forming unit (example conveying device)
60: Dryer (example drying unit)
72: Droplets ejecting device
100: Movable roll (example varying unit)
204: Movable roll (example varying unit)
210: Movable drum (example varying unit)
P**1**: Continuous paper (example recording medium)
P**2**: Cut sheet (example recording medium)

DETAILED DESCRIPTION

Exemplary Embodiment 1

An image forming apparatus according to a first exemplary embodiment of the present invention will be described below.

<Overall Configuration>

First, the overall configuration of the image forming apparatus will be described. The image forming apparatus **10** shown in FIG. **1** is a continuous paper inkjet printer which forms images on continuous paper P**1** being conveyed by inkjet printing.

The image forming apparatus **10** is equipped with an image forming unit **30** which forms images on a portion of continuous paper P**1**, a preprocessing unit **12** which houses a source part of the continuous paper P**1** to be supplied to the image forming unit **30**, and a post-processing unit **14** which houses an image-formed part of the continuous paper P**1** that is ejected from the image forming unit **30**.

The image forming unit **30** of the image forming apparatus **10** is equipped with a control unit **20**, which performs various controls for the entire image forming apparatus **10**. A buffer unit for controlling the conveyance amount etc. of the continuous paper P**1** may be disposed between the preprocessing unit **12** and the image forming unit **30** and between the image forming unit **30** and the post-processing unit **14**.

The continuous paper P**1** is wound on plural conveying rolls **42** and a movable roll **100** and is conveyed along a conveyance path **50** which is formed inside the image forming unit **30**. The movable roll **100**, which is disposed between a droplets ejecting device **72** and a dryer **60**, serves to returns the continuous paper P**1**. A part, between the droplets ejecting device **72** and the dryer **60**, of the conveyance path **50** is called a return path portion **56**. As described later, the movable roll **100** is made movable in the left-right direction in FIG. **1** (+X

and −X directions indicated by arrows in FIG. **2**) by a moving mechanism **150** (see FIGS. **3**A and **3**B).

The droplets ejecting device **72** is disposed inside the image forming unit **30**. The droplets ejecting device **72** has four droplets ejecting heads **70**K, **70**C, **70**M, and **70**Y of four colors (black (K), cyan (C), magenta (M), and yellow (Y)) which eject ink droplets onto the continuous paper P**1** being conveyed along the conveyance path **50**. In the following description, the droplets ejecting heads will be denoted by numeral **70** followed by K, C, M, and Y when they need to be discriminated from each other in terms of color; if not, these suffixes will be omitted.

The droplets ejecting heads **70** of the droplets ejecting device **72** are opposed to an upper flat path portion **52** which is part of the conveyance path **50**. The droplets ejecting heads **70**K, **70**C, **70**M, and **70**Y are arranged in this order in a continuous paper conveyance direction indicated by arrow K.

Each droplets ejecting head **70** is long in the direction that is perpendicular to the continuous paper conveyance direction K. The image forming area of each droplets ejecting head **70** is set greater than the width of the continuous paper P**1**.

Each droplets ejecting head **70** is configured so as to be supplied with ink of the corresponding color from an ink tank (not shown). In this exemplary embodiment, water-based pigment inks are used in each of which a pigment G (see FIGS. **4**A-**4**C) is dispersed in a water-based solvent. To attain high image quality, the inks that are slow to permeate are employed in the exemplary embodiment.

There are no limitations on the method by which each droplets ejecting head **70** ejects ink droplets. Any of known techniques of the thermal type, piezoelectric type, etc. can be used.

Inside the image forming unit **30**, the dryer **60** (described later) is disposed downstream of (under (see FIGS. **1** and **2**)) the droplets ejecting heads **70** in the conveyance direction K.

The preprocessing unit **12** is equipped with a supply roll **16** around which a source part of the continuous paper P**1** to be supplied to the image forming unit **30** is wound. The supply roll **16** is supported by a frame member (not shown) so as to be rotatable in the direction indicated by arrow N.

On the other hand, the post-processing unit **14** is equipped with a takeup roll **18** for taking up an image-formed part of the continuous paper P**1**. As the takeup roll **18** is rotated in the direction indicated by arrow N receiving rotational force from a motor (not shown), the continuous paper P**1** is conveyed along the conveyance path **50**. The continuous paper conveyance speed can be varied by varying the rotation speed of the motor (not shown). The conveyance speed is in a range of 30 to 200 m/min.

<Image Forming Operation>

Next, an image forming process according to which the image forming apparatus **10** forms images on the continuous paper P**1** will be outlined.

The takeup roll **18** of the post-processing unit **14** is rotated, whereby the continuous paper P**1** is given tension in the conveyance direction K and thereby conveyed along the conveyance path **50**.

The droplets ejecting heads **70** of the respective colors of the droplets ejecting device **72** eject ink droplets Q onto the portion, being conveyed along the upper flat path portion **52**, of the continuous paper P**1**, whereby an image is formed on that portion of the continuous paper P**1** (see FIG. **4**B).

As a portion of the continuous paper P**1** is conveyed along a lower flat path portion **54**, the dryer **60** dries the ink droplets, that is, evaporates the water contained therein, and thereby fuses the ink droplets on that portion of the continuous paper P**1** (see FIG. **5**B).

Since the continuous paper conveyance speed is variable, the control unit **20** adjusts the ink droplets ejecting frequency of each droplets ejecting head **70** in accordance with the conveyance speed. Where the productivity increases as the continuous paper conveyance speed increases, a slow conveyance speed is advantageous in terms of conveyance stability and contributes to increase in image quality. Therefore, the user sets the conveyance speed as appropriate by manipulating a control panel (not shown) according to a purpose of printing.

<Moving Mechanism>

Next, a description will be made of the moving mechanism **150** which is disposed adjacent to the return path portion **56** which is the part, between the droplets ejecting device **72** and the dryer **60**, of the conveyance path **50**. The moving mechanism **150** moves the movable roll **100** on which the continuous paper P**1** is wound.

As shown in FIGS. **2** and **3**A, the movable roll **100** is moved in the −X direction (leftward direction in the figures) and the +X direction (rightward direction). In the following description, the movement directions are denoted merely by character X (i.e., the signs "+" and "−" are omitted) when it is not necessary to discriminate between the leftward and rightward directions.

As shown in FIG. **3**A, the moving mechanism **150** includes the movable roll **100**, a roll support member **130**, a shaft **110**, a ball screw **120**, and a motor **140**.

The ball screw **120** includes a screw shaft **122**, a nut **124** (see FIG. **3**B), and balls (not shown) which are disposed between the ball screw **120** and the nut **124**. Thus, the ball screw **120** is a component for converting a rotational movement of the screw shaft **122** into a linear movement of the nut **124**. The screw shaft **122** of the ball screw **120** extends in the X direction, is supported rotatably by a body or the like (not shown) at both ends, and is rotated by the motor **140**.

The shaft **110** extends in the X direction parallel with the screw shaft **122** of the ball screw **120** and fixed to a body or the like (not shown) at both ends.

As shown in FIG. **3**B, the roll support member **130** is configured in such a manner that upper support portions **132**A and **132**B which project upward and lower support portions **134**A and **134**B which project downward. A rotary shaft **132** of the movable roll **100** is supported rotatably by the upper support portions **132**A and **132**B.

As shown in FIG. **3**B, the screw shaft **122** of the ball screw **120** penetrates through the one lower support portion **134**A of the roll support member **130** and the nut **124** of the ball screw **120** is fixed to the one lower support portion **134**A. The shaft **110** penetrates through the other lower support portion **134**B.

When the motor **140** (see FIG. **3**A) is driven and the screw shaft **122** of the ball screw **120** is thereby rotated, the roll support member **130** to which the nut **124** (see FIG. **3**B) is fixed and the movable roll **100** which is supported rotatably by the roll support member **130** are moved in the −X direction or the +X direction.

As shown in FIG. **2**, when the movable roll **100** is moved in the X direction, the conveyance path length of the return path portion **56** which is the part, between the droplets ejecting device **72** and the dryer **60**, of the conveyance path **50** is varied. More specifically, the conveyance path length of the return path portion **56** is increased when the movable roll **100** is moved in the +X direction, and is shortened when the movable roll **100** is moved in the −X direction.

The motor **140** (see FIG. **3**A) is controlled by the control unit **20**. That is, the control unit **20** performs a control of varying the conveyance path length of the return path portion **56** between the droplets ejecting device **72** and the dryer **60**.

<Dryer>

Next, the dryer **60** will be described. As shown in FIG. **2**, the dryer **60** dries ink droplets ejected on the continuous paper P**1**, that is, evaporates the water contained therein (see FIG. **5**B), by radiation heating using plural infrared heaters **62**. The continuous paper P**1** and the infrared heaters **62** are separated by a glass plate **64** which is opposed to the lower flat path portion **54** which is part of the conveyance path **50**.

The output power of the infrared heaters **62** is variable and controlled by the control unit **20**. FIG. **6** shows a state corresponding to a case that the output power of the infrared heaters **62** is high. FIG. **7** shows a state corresponding to a case that the output power of the infrared heaters **62** is low.

The infrared heaters **62** is cooled by a fan (not shown), and high-humidity air that is produced by evaporation of water from ink droplets is discharged by a ventilator (not shown).

<Workings>

Next, a description will be made of how the image forming apparatus **10** according to the exemplary embodiment works.

(Relationship between Image and the Degree of Permeation of Ink Droplets into Continuous Paper)

The left part of each of FIGS. **4**A-**4**C schematically shows a state immediately after ejecting of a droplet Q onto the continuous paper P**1**. The right part of each of FIGS. **4**A-**4**C schematically shows a state that a time has elapsed from the state of the left part and the droplet Q has permeated into the continuous paper P**1**. The elapsed time (permeation time) increases in the order from FIG. **4**A to FIG. **4**C.

The right part of FIG. **4**B schematically shows a case that the permeation of the ink droplet Q into the continuous paper P**1** is proper for its drying by the dryer **60** (see FIG. **2**). A fine image can be obtained if ink droplets being in such a proper permeation state are dried by the dryer **60**.

On the other hand, in the case where as shown in the right part of FIG. **4**A the permeation of the ink droplet Q into the continuous paper P**1** is insufficient because of too short a permeation time, a large amount of ink remains on the surface PA of the continuous paper P**1**, that is, a large amount of pigment particles G exist in the ink remaining on the surface PA. Therefore, even after the drying by the dryer **60**, the fusing of the pigment particles G on the continuous paper P**1** becomes insufficient, as a result of which the pigment particles G are prone to offsetting and smudging.

In the case where as shown in the right part of FIG. **4**C the permeation of the ink droplet Q into the continuous paper P**1** is excessive because of too long a permeation time, only a small amount of ink remains on the surface PA of the continuous paper P**1**, that is, only a small amount of pigment particles G exist in the ink remaining on the surface PA. As a result, the density of a resulting image tends to become too low.

(Relationship between Image and Drying)

The left part of each of FIGS. **5**A-**5**C schematically shows a state that the droplet Q that has permeated properly into the continuous paper P**1** (see the right part of FIG. **4**B) is being dried by the dryer **60**. The right part of each of FIGS. **5**A-**5**C schematically shows a state that a time has elapsed from the state of the left part and the droplet Q has been dried. The elapsed time (drying time), that is, the drying energy, increases in the order from FIG. **5**A to FIG. **5**C.

A fine image is obtained if ink droplets are dried properly as shown in FIG. **5**B.

On the other hand, in the case where as shown in the right part of FIG. **5**A the drying time is too short (the drying energy is insufficient), the evaporation of water from droplets is insufficient and they are not dried completely, to possibly cause offsetting or smudging.

In the case where as shown in the right part of FIG. **5**C the drying time is too long (the drying energy is excessive), the evaporation of water from droplets is excessive and a large amount of pigment particles G remain on the surface PA. Therefore, the fusing of the pigment particles G on the continuous paper P**1** becomes insufficient, as a result of which the pigment particles G are prone to offsetting and smudging.

(Control of Varying the Conveyance Path Length from Droplets Ejecting Device to Dryer)

As shown in FIG. **2** etc., ink droplets Q that have been ejected on the continuous paper P**1** by the droplets ejecting device **72** (see the left parts of FIGS. **4**A-**4**C) permeate into the continuous paper P**1** (see the right parts of FIGS. **4**A-**4**C) while being conveyed along the return path portion **56** and then dried by the dryer **60** (see the right parts of FIGS. **5**A-**5**C).

In the image forming apparatus **10** according to the exemplary embodiment, the continuous paper conveyance speed is variable. Therefore, if the conveyance path length of the return path portion **56** were fixed, the time taken by ink droplets to pass the return path portion **56** would vary depending on the conveyance speed. Therefore, the ink droplets permeation time, and hence the degree of permeation, would vary depending on the continuous paper conveyance speed. That is, the permeation might would become insufficient (right part of FIG. **4**A) or excessive (left part of FIG. **4**C), to cause an image failure such as offsetting or smudging of pigment particles G or density reduction.

In view of the above, in the exemplary embodiment, the control unit **20** moves the movable roll **100** in the X direction using the moving mechanism **150** shown in FIGS. **3**A and **3**B and thereby varies the conveyance path length of the return path portion **56** so that the ink droplets permeation time falls within a predetermined range, that is, ink droplets Q being in the state shown in the right part of FIG. **4**B are dried by the dryer **60**.

More specifically, as shown in FIG. **6**, when the continuous paper conveyance speed is high, the control unit **20** moves the movable roll **100** in the +X direction and thereby increases the conveyance path length of the return path portion **56**. As shown in FIG. **7**, when the continuous paper conveyance speed is low, the control unit **20** moves the movable roll **100** in the −X direction and thereby shortens the conveyance path length of the return path portion **56**.

As a result, the ink droplets permeation time falls within the predetermined range, that is, the degree of permeation of ink droplets Q falls within an allowable range, irrespective of the continuous paper conveyance speed. Thus, the occurrence of an image failure (e.g., offsetting or smudging of pigment particles G or image density reduction) that may occur because the permeation of ink droplets Q into the continuous paper P**1** is improper when they are dried by the dryer **60** can be suppressed.

Furthermore, in the exemplary embodiment, the control unit **20** controls the output power of the infrared heaters **62** of the dryer **60** so that the drying energy that the continuous paper P**1** receives in the dryer **60** falls within a predetermined range.

More specifically, as shown in FIG. **6**, when the continuous paper conveyance speed is high, the control unit **20** increases the output power of the infrared heaters **62** of the dryer **60**. As shown in FIG. **7**, when the continuous paper conveyance speed is low, the control unit **20** lowers the output power of the infrared heaters **62** of the dryer **60**. In FIGS. **6** and **7**, the size of arrows that originate from the infrared heaters **62** represents the magnitude of their output power.

As a result, the drying energy that the continuous paper P1 receives in the dryer **60** falls within the predetermined range and hence the degree of drying of ink droplets does not vary much irrespective of the continuous paper conveyance speed. Thus, the occurrence of an image failure due to improper drying of ink droplets can be suppressed.

Embodiment 2

An image forming apparatus according to a second exemplary embodiment of the invention will be described below. Components having the same ones in the first exemplary embodiment will be given the same reference symbols as the latter, and will not be described redundantly.

<Overall Configuration>

The image forming apparatus **11** shown in FIG. **8** is a sheet-fed printer which forms images on cut sheets P2 being conveyed by inkjet printing.

The image forming apparatus **11** is equipped with an image forming unit **31** which forms images on cut sheets P2, a preprocessing unit (not shown) which houses cut sheets P2 to be supplied to the image forming unit **31**, and a post-processing unit (not shown) which houses cut sheets P2 that are ejected from the image forming unit **31**. The image forming unit **31** of the image forming apparatus **11** is equipped with a control unit **20**, which performs various controls for the entire image forming apparatus **11**.

A cut sheet P2 is conveyed by plural conveying rolls **43** and a conveying belt **200** along a conveyance path **51** which is formed inside the image forming unit **31**.

Droplets ejecting heads **70** of a droplets ejecting device **72** are opposed to an upper flat path portion **53**, that is, an upper flat portion of the conveying belt **200**. Inside the image forming unit **31**, a dryer **60** is disposed downstream of (under (see FIG. **10**)) the droplets ejecting heads **70** in a conveyance direction K. The dryer **60** is opposed to a lower flat path portion **55**, that is, a lower flat portion of the conveying belt **200**.

A cut sheet P2 is conveyed as the conveying belt **200** is moved in the conveyance direction K receiving rotational force from a motor (not shown) in a state that the cut sheet P2 is stuck to it as a result of operation of a sticking means (not shown). The conveyance speed of a cut sheet P2 being conveyed by the conveying belt **200** can be varied by varying the movement speed of the conveying belt **200** by varying the rotation speed of the motor (not shown).

<Conveying Belt Moving Mechanism>

Next, a description will be made of a conveying belt moving mechanism **150**. The conveying belt **200** is wound on plural rolls **202**, a movable roll **204**, and a movable drum **210**. The movable roll **204** and the movable drum **210** are moved in an X direction by a mechanism with a ball screw which is similar to the moving mechanism **150** used in the first embodiment (see FIGS. **3**A and **3**B).

When the movable roll **204** and the movable drum **210** are moved in the X direction, the conveyance path length of a return path portion **57** which is a part, between the droplets ejecting device **72** and the dryer **60**, of the conveyance path **51** is varied. More specifically, the conveyance path length of the return path portion **57** is increased when the movable drum **210** is moved in the +X direction and the movable roll **204** is moved in the −X direction accordingly. The conveyance path length of the return path portion **57** is shortened when the movable drum **210** is moved in the −X direction and the movable roll **204** is moved in the +X direction accordingly.

The movable drum **210** and the movable roll **204** are controlled by the control unit **20**. That is, the control unit **20** performs a control of varying the conveyance path length of the return path portion **57** between the droplets ejecting device **72** and the dryer **60**.

<Workings>

Next, a description will be made of how the image forming apparatus **11** according to the exemplary embodiment works.

In this exemplary embodiment, as in the first exemplary embodiment, the control unit **20** moves the movable drum **210** and the movable roll **204** in the X direction and thereby varies the conveyance path length of the return path portion **57** so that the time during which ink droplets permeate into a cut sheet P2 falls within a predetermined range.

More specifically, when the conveyance speed is high, the control unit **20** moves the movable drum **210** in the +X direction and thereby increases the conveyance path length of the return path portion **57**. When the conveyance speed is low, the control unit **20** moves the movable drum **210** in the −X direction and thereby shortens the conveyance path length of the return path portion **57**.

As a result, the ink droplets permeation time falls within the predetermined range, that is, the degree of permeation of ink droplets Q falls within an allowable range, irrespective of the cut sheet conveyance speed. Thus, the occurrence of an image failure (e.g., offsetting or smudging of pigment particles G or image density reduction) that may occur because the permeation of ink droplets Q into a cut sheet P2 is improper when they are dried by the dryer **60** can be suppressed.

Furthermore, in this exemplary embodiment, as in the first exemplary embodiment, the control unit **20** controls the output power of infrared heaters **62** of the dryer **60** so that the drying energy that a cut sheet P2 receives in the dryer **60** falls within a predetermined range.

More specifically, when the cut sheet conveyance speed is high, the control unit **20** increases the output power of the infrared heaters **62** of the dryer **60**. When the cut sheet conveyance speed is low, the control unit **20** lowers the output power of the infrared heaters **62** of the dryer **60**. As a result, the drying energy falls within the predetermined range and hence the degree of drying of ink droplets does not vary much, whereby the occurrence of an image failure due to improper drying of ink droplets can be suppressed.

<Modifications>

Next, modifications of the exemplary embodiments will be described below. Although the modifications will be described using the drawings (FIGS. **1** and **2** etc.) corresponding to the image forming apparatus **10** according to the first exemplary embodiment, the concepts of the modifications are likewise applicable to the image forming apparatus **11** according to the second exemplary embodiment (see FIG. **7**).

(Modification 1)

In the exemplary embodiments, the drying energy that continuous paper P1 (or cut sheet P2) receives is set within the predetermined range by adjusting the output power of all the infrared heaters **62** (see FIGS. **6** and **7**) in accordance with the conveyance speed of the continuous paper P1 (or cut sheet P2). However, the invention is not limited to such a case.

For example, as in a first modification shown in FIG. **9**, the drying energy that continuous paper P1 (or cut sheet P2) receives may be set within the predetermined range by varying the number of turned-on infrared heaters **62** in accordance with the conveyance speed of the continuous paper P1 (or cut sheet P2). That is, the number of turned-on infrared heaters **62** is increased when the conveyance speed is high, and is decreased when the conveyance speed is low.

Alternatively, the drying energy that continuous paper P1 (or cut sheet P2) receives may be set within the predetermined

range by varying both of the output power of the infrared heaters **62** and the number of turned-on infrared heaters **62** in accordance with its conveyance speed.

(Modification 2)

In the exemplary embodiments, the conveyance path length of the return path portion **56** (or **57**) is varied by moving the movable roll **100** (or movable drum **210**) as shown in FIGS. **2** and **3**A so that the permeation time falls within the predetermined range. However, the invention is not limited to such a case.

For example, as in a second modification shown in FIG. **10**A, the conveyance path length may be increased by shifting, to the downstream side, the turning-on start position (drying start position) of the infrared heaters **62**, that is, the position of the upstream end infrared heater **62** of turned-on infrared heaters **62**, in accordance with the conveyance speed of continuous paper P**1** (or cut sheet P**2**). The number of turned-on infrared heaters **62** is increased at the same time. As shown in FIG. **10**B, the conveyance path length may be shortened by shifting, to the upstream side, the turning-on start position (drying start position) of the infrared heaters **62**, that is, the position of the upstream end infrared heater **62** of turned-on infrared heaters **62**, in accordance with the conveyance speed of continuous paper P**1** (or cut sheet P**2**). The number of turned-on infrared heaters **62** is decreased at the same time.

In this configuration, the movable roll **100** (or movable drum **210**) is not moved (i.e., its position is fixed).

Alternatively, the conveyance path length may be varied by using both of the movement of the movable roll **100** (or movable drum **210**) and the turning-on start position (drying start position) of the infrared heaters **62**.

Still further, the drying energy that continuous paper P**1** (or cut sheet P**2**) receives may be set within the predetermined range by varying both of the output power of the infrared heaters **62** and the number of turned-on infrared heaters **62**.

<Other Modifications>

In the above-described exemplary embodiments and modifications, the conveyance path length from the droplets ejecting device **72** to the dryer **60** is varied in accordance with the conveyance speed of the recording medium (continuous paper P**1** or cut sheet P**2**) so that the permeation time falls within a predetermined range (i.e., ink droplets being in the state shown in the right part of FIG. **4**B are dried by the dryer **60**). However, the invention is not limited to such a case.

The droplets (ink droplets) permeation speed varies depending on the permeation characteristic of the recording medium (continuous paper P**1** or cut sheet P**2**), that is, the type of recording medium. In the case of a recording medium (continuous paper P**1** or cut sheet P**2**) having a permeation characteristic that the permeation speed is low, a large amount of ink tends to remain on the surface of the recording medium as in the case that the permeation time is so short that the permeation becomes insufficient (see the right part of FIG. **9**A), as a result of which pigment particles G are prone to offsetting and smudging.

In the case of a recording medium (continuous paper P**1** or cut sheet P**2**) having a permeation characteristic that the permeation speed is high, only a small amount of ink tends to remain on the surface of the recording medium as in the case that the permeation time is so long that the permeation becomes excessive (see the right part of FIG. **4**C), as a result of which the image density is prone to become low.

In view of the above, the conveyance path length from the droplets ejecting device **72** to the dryer **60** may be varied in accordance with the droplets permeation characteristic of the recording medium (continuous paper P**1** or cut sheet P**2**). In this case, conveyance path lengths that are suitable for types of recording media (continuous paper P**1** or cut sheets P**2**), that is, permeation characteristics of recording media, are determined in advance by experiments, for example, and stored in a storage means of the control unit **20** in advance. FIG. **11** is a table showing example relationships between droplets permeation characteristics (permeation speeds) and conveyance path lengths of various types of recording media.

The user selects a type of recording medium such as continuous paper P**1** or a cut sheet P**2** (i.e., a permeation characteristic (permeation speed)) by manipulating a control panel (not shown). Based on the selection result, the control unit **20** varies the conveyance path length by moving the movable roll **100** or the movable drum **210** in the X direction. More specifically, the conveyance path length is increased when the droplets permeation speed of the recording medium (continuous paper P**1** or cut sheet P**2**) is low, and is shortened when the droplets permeation speed is high.

The conveyance path length may be varied in accordance with both of the conveyance speed and the droplets permeation speed of the recording medium (continuous paper P**1** or cut sheet P**2**).

In the above-described exemplary embodiments and modifications, droplets (ink droplets) ejected on continuous paper P**1** or a cut sheet P**2** are dried by evaporating water from them by radiation heating using the plural infrared heaters **62**, the invention is not limited to such a case. A dryer (drying means) having any configuration may be employed as long as it has the function of drying droplets (ink droplets) by evaporating water from them.

The configuration of the image forming apparatus is not limited to the configurations described in the exemplary embodiments and the modifications but various other configurations may be employed. Furthermore, it goes without saying that the invention can be practiced in various forms without departing from the spirit and scope of the invention.

What is claimed is:

1. An image forming apparatus comprising:

a conveying device that conveys a recording medium in a conveyance direction;

a droplets ejecting device that ejects droplets onto the recording medium being conveyed by the conveying device;

a drying unit that dries the droplets that have been ejected on the recording medium being conveyed by the conveying device, the drying unit comprising a plurality of infrared heaters arranged in the conveyance direction; and

a varying unit that varies a conveyance path length from the droplets ejecting device to the drying unit in accordance with at least one of a conveyance speed of the recording medium and an ejected droplets permeation characteristic of the recording medium,

wherein the varying unit varies the conveyance path length by varying a drying start position, on an upstream side in the conveyance direction, in a drying area of the drying unit by selecting at least one of the plurality of infrared heaters to be turned on.

2. The image forming apparatus according to claim **1**, wherein the drying unit adjusts an output power of the drying unit in accordance with the conveyance speed of the recording medium.

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